(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 838 708 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.04.1998 Bulletin 1998/18

(51) Int Cl.6: **G02B 23/12**

(21) Application number: **97850142.7**

(22) Date of filing: **20.10.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV RO SI

(30) Priority: **24.10.1996 SE 9603895**

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(54) **Binocular image intensifier viewer**

(57) In order to obtain in a folded image intensifier viewer with an asymmetric viewing system and a single image intensifier and two eyepieces the possibility to regulate the mutual distance between the eyepieces, after a beam splitter which divides the beam path into two extremely asymmetric parts, for each eyepiece a lens system (8A,9A;8B,9B) is provided with at least one having at least two lenses.

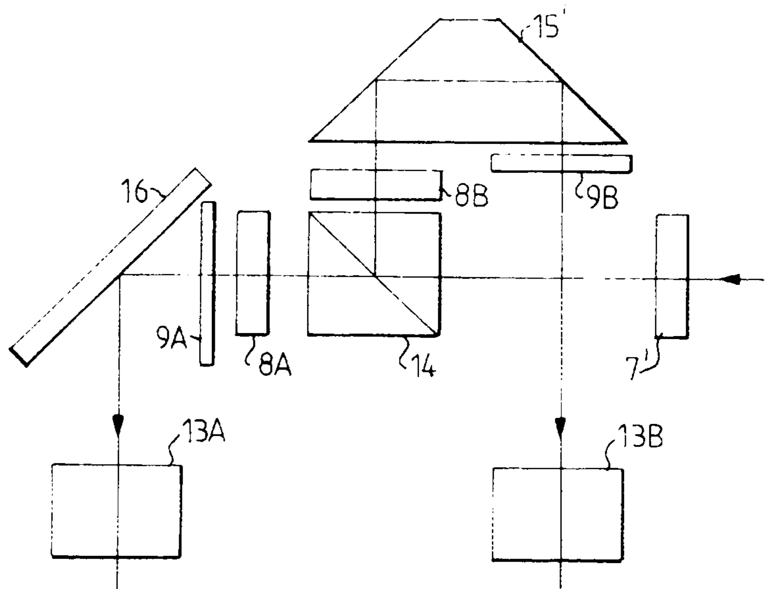

FIG. 2B

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Description

The invention relates to an image intensifier viewer of the type which is stated in the preamble of claim 1.

Such an image intensifier viewer, also called goggles, is known from Swedish Patent No. 450 671 (8503533-5). As is evident from this document such nightviewers have great advantages, when it is a question of size and above all through having the centre of gravity able to be placed near to the head with a minimal construction in front, which makes such a nightviewer considerably more comfortable to wear than the previously known constructions of this type.

This known construction is shown in Fig. 1 which is taken from said patent document. Fig. 2A shows most of the viewing system with lenses 7 and 8, beam splitter 14, the two split beam parts thereafter, for the left eye mirror 16 and eyepiece 13A, and the for right eye prism 15 and eyepiece 13B. The outgoing beams of rays from the lens 8 are then each focused in an intermediate image in front of the two eyepieces 13A and 13B. It is evident that the mechanical beam for the right eye is longer than that for the left. The optical construction length is, however, very nearly the same for both beam parts, thanks to the optical path being reduced by means of a suitable choice of glass in the prism 15.

This construction is rigid in that it is practically impossible to adjust the distance between the eyepieces to compensate for different distances between the eyes. This problem receives a sort of inadequate solution in the known construction through the egress pupils for the eyepieces being on the generous size so that a large number of users do not experience any great requirement for such an adjustment. The more an observer's distance between the eyes differs from the average distance of 66 mm, the worse, however, becomes the optical performance as the correction is optimized for the centre of the egress pupils. Amongst others, the field of view vignette rings increase and the sharpness deteriorates.

However, in many cases for obvious reasons it is an urgent and sometimes imperative requirement, especially from military buyers, that such a possibility of adjustment nevertheless is present. Otherwise the binocular viewer cannot be used by everybody which in certain connections is an unacceptable state of things. The inconvenience of a fixed distance between the eyes consequently increases with reduced eyepiece pupils. Further difficulties therefore occur when one wishes to miniaturize image intensifier viewers, for example by means of smaller eyepieces and therefore reduced egress pupils. Furthermore, there are more often requirements for a larger field of view which often reduces the focal length of the eyepieces, and this is more and more difficult to combine with the large egress pupils which are necessary in order to be able to accept the lateral immovability of the eyepieces.

According to the invention these problems are eliminated through making one eyepiece movable. The requirements which must in this case be satisfied are partially the same as those for the known construction, viz. that the eyepieces must project equally far from the instrument casing and this also after adjustment of the distance between them, and that the magnification in the two eyepieces therewith must remain mutually equal. The latter presents special difficulty on the grounds that the construction is not symmetrical but in fact the left and right eyepiece systems are completely different, with, amongst others, different optical lengths, a difference which is corrected through using different optical constructions in the respective eyepiece channel, so that their so-called tele effect differs, and this is made possible through each part of the lens after the beam splitter containing a sufficient number of lens elements to achieve such an optical degree of freedom.

The above objects and advantages and others, which are evident from the continued description, are consequently achieved according to the invention through a binocular image intensifier viewer of the type mentioned in the introduction, which has the features which are given in the characterizing part of claim 1. Advantageous embodiments are evident from the subclaims.

The invention will now be described in the form of a non-limiting example of an embodiment and with reference to the Figures. Fig. 1 shows schematically in a perspective view a known binocular image intensifier viewer with a fixed distance between the eyes. Fig. 2A shows a part of the beam in the same image intensifier viewer but in a schematic plan view. Fig. 2B shows a viewing system according to the invention with a variable eyepiece distance.

Figs. 1 and 2A have already been described above. Fig. 2B can suitably be compared with Fig. 2A in order to see how the invention differs from that which is already known.

In the known construction in Fig. 2A, lens 7 is a collimation lens which reproduces the output plane of the light intensifier tube at an infinite distance. The lens 8 focuses the collimated beams from the lens 7 towards the respective eyepieces 13A and 13B. As is shown, the geometric/mechanical path for the right beam part is longer than that of the left here. Through choosing types of glass with a suitably high refractive index in the prism 15 the optical path is, however, reduced.

In Fig. 2B the lens 8 in front of the beam splitter 14 has been eliminated. The parallel beams from the lens 7 are instead focused in each beam individually by the lenses 8A resp. 8B. Instead of a lens 8 refracting for both paths, here in each part consequently an individual lens 8A resp. 8B has been inserted. This leads to that the collimated light from lens 7 now continues through the beam splitter and onto the lens 8A, permitting the important fact and the effect which is the aim of the invention, that this eyepiece 13A now can move laterally together with the mirror 16 and the lens 8A without causing

the eyepiece focusing (13A), i.e. the dioptric adjustment, to need to be adjusted. Through this arrangement, viz. by moving the collimation lens 8 from a position in front of the beam splitter to one after the same, then unfortunately the available optical path through each of the channels is correspondingly shortened. With reference to the already earlier (Fig. 2A) shown certain mutual differences, the percentage differences (Fig. 2B) will therefore be increased.

A particular problem here is that it is mechanically tight; the distance between the eyepieces being defined by the human measurement of 66 mm. Furthermore, there must be sufficient space present for the different parallel beams of rays to be able to pass through the whole lens system without unacceptable vignetting.

In order to solve this problem, according to the invention optical solutions with several lenses are provided, so constructed that the system focal length in the respective eyepiece channels remains the same, even despite the optical and mechanical construction in the two channels being different.

Through a suitable choice of geometric configurations and refractive power distribution in the respective part systems in the beam path from the intensifier tube to the eyepieces, it has been shown to be possible, however, to still fit the system into the available space.

The solution which is suggested according to the example of an embodiment is consequently that the refracting lens 8 is swapped for two refracting lenses 8A, 8B, placed after the beam splitter 14A (which can be a mirror or, as illustrated, a prism construction), complemented with each having a lens for correction of magnification and construction length. An example thereof is shown in Fig. 2B. The correction lens 9A is placed between the mirror 16 and the collimation lens 8A. The correction lens 9B is mounted close to the prism 15 at its output side, where it cannot obscure the common beam path between lens 7 and the beam splitter 14. Other positions are possible but it has shown that the aforementioned is advantageous and permits good correction and eyepiece fields of view greater than 50°.

As is known to the person skilled in the art, with the further degree of freedom which is obtained by several lenses, an improved correction of different image errors such as distortion, astigmatism and colour errors is made possible. It is true that the phosphorus in the output surface of a light intensifier is green but it is not a pure spectral colour and therefore an achromatization is still necessary.

In certain cases it is possible to have only one refracting lens in one part of the beam path wherewith one compensates to an equal magnification by means of the lens elements in the other part of the beam path. However, in general it is preferred to have at least one correction lens in each part of the beam path, as in that case one obtains several degrees of freedom during construction concerning geometry and magnification and naturally the reduction of reproduction errors.

It is clear that the magnification must be the same in the two systems as the wearer otherwise will have problems such as headache and double vision. It is necessary that the pictures also are similar concerning, for example, distortion and field of view bending. The increased degree of freedom concerning the design of the different lenses according to the invention is necessary in order to provide this.

As the skilled person knows, the calculation of the lenses and their positions is performed with the help of commercial computer problems, where one starts from a geometrically suitable configuration which is optimized through successive iterations.

It is normally desired in a binocular nightviewer that it obtains an magnification of 1:1, and this magnification which is achieved by the lens combination in the respective eyepiece branches is in this case dependent on the focal length for the objective which reproduces the night scene on the image intensifier tube's input plane. However, the invention is not limited to this, in itself, generally advantageous unitary magnification as it is also normal that, for example, a so-called teleconverter is placed in front of the objective on these instruments in order to thereby achieve other magnifications.

Unitary magnification can be achieved if the objective 1 and the eyepieces have the same focal length and the optical transport system from the image intensifier's output to the eyepieces has a unitary magnification. Otherwise, for achieving a unitary magnification the following conditions apply;

$$f(oc) = G \cdot f(obj),$$

where f(obj) is the said objective's focal length, f(oc) is the focal length of the eyepiece, and G is the magnification between the intensifier tube's image on the phosphorous screen to the intermediate image in the image plane of the eyepieces.

Claims

1. Binocular image intensifier viewer of the type which has a single image intensifier (2), an objective (1) for reproducing a scene on the image intensifier and two eyepieces (13A, 13B) and where the image intensifier is orientated perpendicular to the aiming direction and, in relation to a user, parallel with a line which joins the eyes, and with an optical viewing system after the image intensifier which has its main beam path in the same plane as the eyes of the user and perpendicular to the optical axes of the eyepieces, with an asymmetric beam path comprising a beam splitter (14) which divides the viewing system into a first and a second part, where the first part is reflected by the beam splitter, and the second part is formed by rays which without being reflected

pass through the beam splitter, while the image intensifier and associated objective (1) are placed in a plane separated from a line uniting the eyes of a user, **characterized** in that the beam splitter (14) is arranged in a collimated beam path from a first lens (7) which represents the image intensifier's light-intensified picture at infinity, and special lens means produce a picture thereof for each eyepiece, and that the special lens means are divided into two separate lens means parts, arranged each in their own of the said parts of the viewing system and after the beam splitter (14), that at least one of the lens means parts comprises at least two lenses, and that one eyepiece (13A), viz. that which is in the beam path transmitted by the beam splitter, is together with the associated lens means part movably mounted for changing the mutual distance between the eyepieces.

2. Image intensifier viewer according to Claim 1, **characterized** in that both lens means parts each comprise at least two lenses.

3. Image intensifier viewer according to Claim 1, **characterized** in that the lens means part in the second part of the viewing system consists of a first lens (8A) and a second lens (9A) mounted in a movable eyepiece unit together with a reflection unit (16) and the said eyepiece (13A), which both lenses are arranged beam-path-wise before the reflection unit.

4. Image intensifier viewer according to any of the previous claims, **characterized** in that in the first part of the viewing system the lens means part comprises at least two lenses (8B,9B), which are arranged beam-path-wise each on one side of the said reflecting surfaces (15), seen as a unit.

5. Image intensifier viewer according to any of Claims 1 - 3, **characterized** in that in the first part of the viewing system the lens means part comprises at least two lenses, which are arranged beam-path-wise with one of the lenses between the said reflecting surfaces (15).

6. Image intensifier viewer according to Claim 1 or 2, **characterized** in that in the second part of the viewing system the lens means part consists of at least a first lens (8A) and a second lens (9A) mounted in a movable eyepiece unit together with a reflection unit (16) and the said eyepiece (13A), whereby the first lens is arranged beam-path-wise before the reflection unit and the said second lens is arranged beam-path-wise between the reflection unit and the said eyepiece.

7. Image intensifier viewer according to any of the previous claims, **characterized** in that it has a unitary magnification.

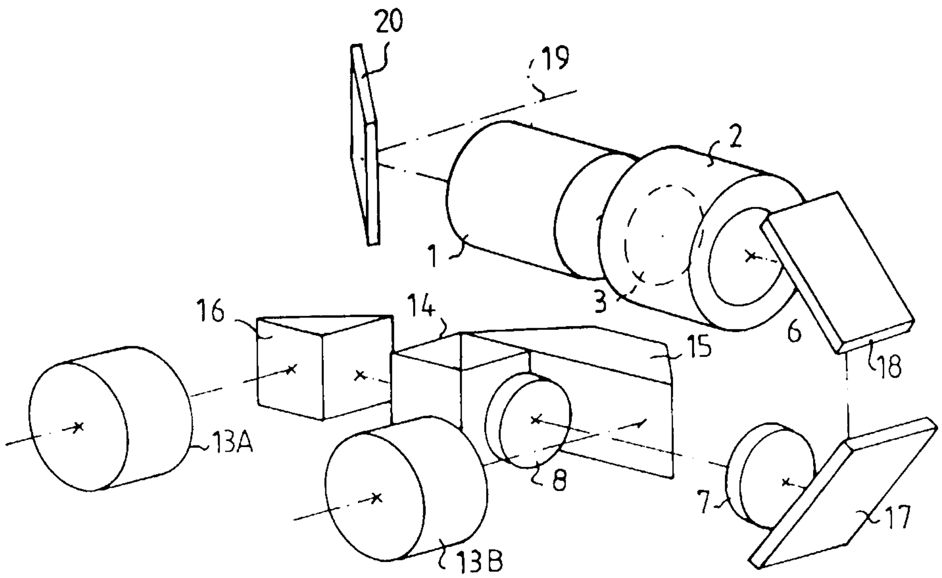

FIG. 1

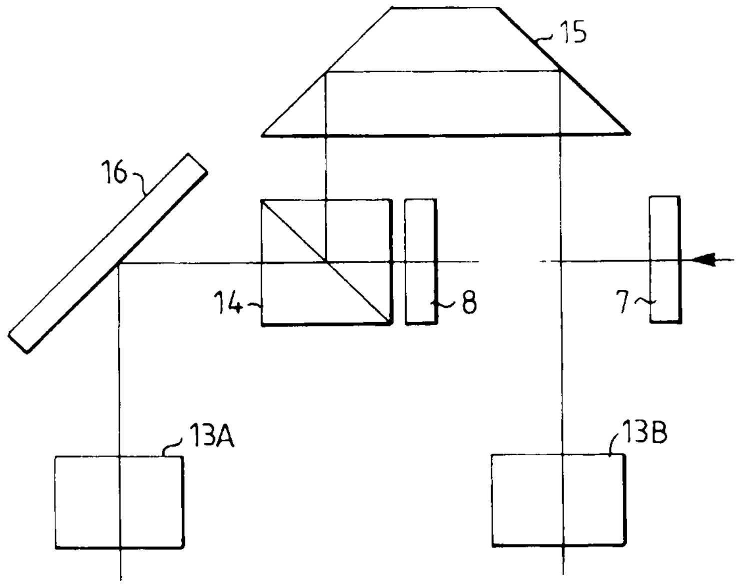

FIG. 2A

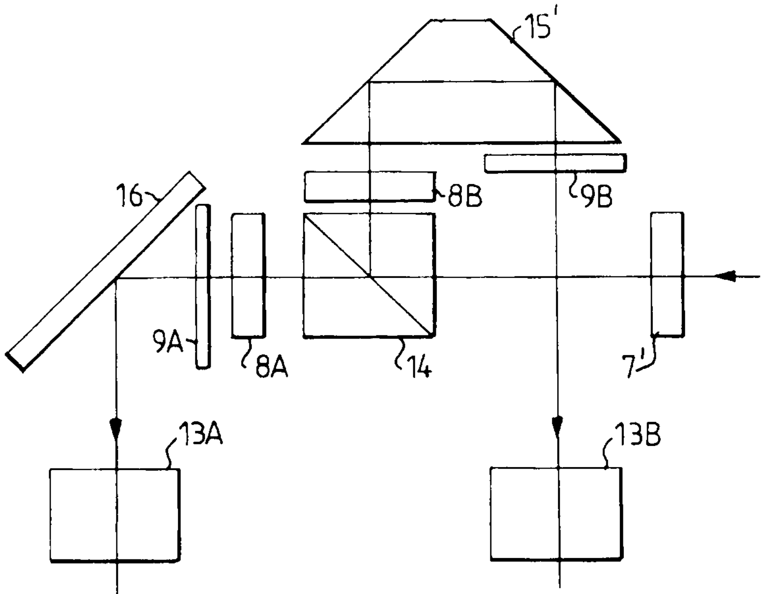

FIG. 2B

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EUROPEAN SEARCH REPORT

Application Number
EP 97 85 0142.7

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.6)
Y	WO 9600924 A1 (ANGENIEUX S.A.), 11 January 1996 (11.01.96) * figure 1, abstract *	1,4,7	G02B 23/12
A		2,3,5,6	
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A,D	SE 450671 B (S.-Å. AFSENIUS), 13 July 1987 (13.07.87) * figur, abstract *	1-7	
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A	US 4737023 A (W.A. KASTENDIECK ET AL), 12 April 1988 (12.04.88) * figure 2, abstract *	1	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	22 January 1998	VON FRIESENDORFF FILIP

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
EP 97 85 0142.7

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.6)
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A	FR 718534 A1 (SOPELEM-SOFRETEC (S.A.)), 13 October 1995 (13.10.95) * figure 3, abstract * --	1	
A	GB 2006463 A (HUGHES AIRCRAFT COMPANY), 2 May 1979 (02.05.79) * figure 7, abstract * --	1	
A	SE 467278 B (S.-Å. AFSENIUS), 22 June 1992 (22.06.92) * figure 2 * -----	1	TECHNICAL FIELDS SEARCHED (Int. Cl.6)

The present search report has been drawn up for all claims

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